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# Wetland Plants of Specialized Habitats in the Arid West

Robert Lichvar and Lindsey Dixon

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Cover: Desert bluebells in a dry wash in the Mojave Desert, CA.

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*Cold Regions Research and Engineering Laboratory*
*U.S. Army Engineer Research and Development Center*
*72 Lyme Road*
*Hanover, NH 03755-1290*



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**Abstract:** The U.S. Army Corps of Engineers is currently regionalizing and updating the national wetland delineation manual. This manual will use new ecosystem boundaries for the nation. A separate effort by the Corps will update the National Wetland Plant List within these same new ecosystem boundaries. The Arid West is an area of particular interest in the revision of the plant list because of the problematic indicator statuses for certain groups of plants. Many species in the Arid West have morphological and physiological adaptations that allow them to occur in specialized habitats, ranging from wetlands to uplands. In delineations, the indicator status of these species is not always accurate for the specific location. A combination of literature reviews and recorded species data from previous studies for six specialty habitats are presented and discussed; the species groups are playa edge species, dry wash species, dry wash phreatophytes, hygro-halophytes, xero-halophytes, and phreatophytes with salt tolerance. A total of 421 species, with 93 of those species shared in more than one habitat type, are reported, including 48 playa species, 346 dry wash species, 62 dry wash phreatophytes, 32 hygro-halophytes, 47 xero-halophytes, and 17 phreatophytes with salt tolerance. The list for each specialized habitat will be used to better understand species ecology and occurrences across the region and will ultimately help in assigning and increasing the reliability of wetland plant indicator statuses.

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# Preface

This report was prepared by Robert W. Lichvar and Lindsey Dixon, Remote Sensing/GIS and Water Resources Branch, Cold Regions Research and Engineering Laboratory (CRREL), U.S. Army Engineer Research and Development Center (ERDC), Hanover, NH.

Many military installations over the years supported various types of studies that helped in generating a list of species that could be used in this study. These include White Sands Missile Range, NM; Edwards Air Force Base (AFB), CA; Dugway Proving Ground, UT; Twenty Nine Palms Marine Corps Base, CA; Camp Pendleton, CA; and Miramar Marine Corps Station, CA. Many supporters of other studies allowed for a robust list to be developed in this region, including the Navajo Nation and the San Francisco, Los Angeles, and Sacramento Districts, Corps of Engineers. The authors thank David Charlton of Edwards AFB for making comments on the list of species and their synonyms and Corinna Photos for reviewing and editing the manuscript. Finally they thank the vegetation working group for the Arid West wetland supplement, who felt that there was a need for such a list and discussion and that it would be helpful for wetland delineation purposes.

The report was prepared under the general supervision of Timothy Pangburn, Chief, Remote Sensing/GIS and Water Resources Branch; Dr. Lance Hansen, Deputy Director; and Dr. Robert E. Davis, Director, CRREL.

The Commander and Executive Director of ERDC is COL Richard B. Jenkins. The Director is Dr. James R. Houston.

# 1 Introduction

The U.S. Army Corps of Engineers is regionalizing and updating (Wakeley 2002) its national wetland delineation manual (Environmental Laboratory 1987). As part of this effort, the nation is being subdivided along ecosystem boundaries (Fig. 1) similar to those used for the indicators of hydric soils (NRCS 2006b). Starting in 2007, using these same boundaries, the Corps began to regionalize the Corps National Wetland Plant List as part of a Memorandum of Agreement (MOA) between the Corps of Engineers, the Fish and Wildlife Service (FWS), the Natural Resources Conservation Service (NRCS), and the Environmental Protection Agency (EPA). One of these new regions (the Arid West)


Figure 1. Plant list regional boundaries (red lines) currently used by the U.S. Fish and Wildlife Service's National Wetlands Inventory in the Arid West.

comprises five former U.S. Fish and Wildlife Service (FWS) regional areas. The FWS regional areas were defined by administrative boundaries and were previously used for regional wetland plant indicator status lists (Reed 1988). Due to the updating of the National Wetland Plant List along ecosystem boundaries, only those wetland species occurring within the new boundary of the Arid West region will be included in the revision of the wetland plant list for the region. In the new Arid West region, along with other new regions nationally, the ecosystem boundaries will be more closely aligned with climatic, geologic, landform, other environmental condition, and there will be an increased similarity of floristic composition within the region. The use of ecosystem boundaries for wetland plant lists in different regions will increase the reliability and accuracy of the wetland plant indicator statuses.

Species containing ecotypes or those with wide ecological amplitudes (Tiner 2006) can make determinations of hydrophytic vegetation challenging if they have the ability to occur in multiple habitats that range from wetlands to uplands. In the Arid West, certain species are located in specialized habitats, including riparian corridors, playas, and saline areas. Many of these habitats can be considered either wetlands or uplands, depending on specific site conditions. In wetland delineation, these habitats can be problematic when the vegetation is a mixture of hydrophytes (plants occurring in wetlands) and other species that have physiological or morphological adaptations for growing in these specialized western habitats (Gibson 1996, Nilsen et al. 1984, Hunt 1966). This is especially true if all of these adaptations are not factored into the wetland rating.

In wetland delineation, the determination of the presence or absence of hydrophytic vegetation at a site requires the use of species abundances, wetland indicator status ratings (Reed 1988), and several mathematical formulas to determine if hydrophytes dominate the site. For a reliable determination of hydrophytic vegetation, it is critical that a species be accurately assigned a wetland indicator status based on its frequency of occurrence in wetlands in the region (Table 1). The ability to sort these occurrences into different habitats or adaptations adds clarity to the wetland plant ratings. For instance, many of the specialized western habitats are highly saline areas with groundwater deeper than that required to be considered a wetland. In the Arid West many species have evolved morphological or physiological adaptations that allow them to

Table 1. Indicator categories.

| Indicator code | Category | Definition | % Occurring in wetlands |
|---|---|---|---|
| OBL | Obligate Wetland | Occurs almost always in wetlands under natural conditions | >99% |
| FACW | Facultative Wetland | Usually occurs in wetlands, but often found in non-wetlands | 67–99% |
| FAC | Facultative | Equally likely to occur in wetlands or non-wetlands | 34–66% |
| FACU | Facultative Upland | Usually occurs in non-wetlands, but often found in wetlands | 1–33% |
| UPL | Obligate Upland | Occurs almost always in non-wetlands under natural conditions | <1% |
| NA | No agreement | The regional panel was not able to reach a decision on this species. | N/A |
| NI | No indicator | Insufficient information was available to determine an indicator status. | N/A |
| NO | No occurrence | The species does not occur in that region. | N/A |
| (+) or (-) | Facultative | A positive (+) or negative (–) sign was used with the Facultative indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands). A negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands). | |
| An asterisk (*) following a regional indicator identifies uncertain designations based on limited information from which to determine the indicator status. | | | |

inhabit these sites. Clarifying differences in occurrences in specialized habitat types, such as wetlands, other waters of the United States (WoUS), or uplands allows for a better understanding of a species and its frequency of occurrence in wetlands, and this in turn will increase the reliability of wetland indicator statuses.

To support the updating of the vegetation section of the Arid West Regional Supplement and the revision of the Corps National List of Wetland Plants, an effort was undertaken to identify some of the specialized habitats of the Arid West and compile species lists for these habitats. To further assist regional panels of wetland specialists and botanists in assigning indicator statuses to these species, a detailed habitat description or discussion of morphological and physiological adaptations of species was developed using the literature and field knowledge to circumscribe these habitats for the Arid West. Previous efforts for reporting lists of species from these habitats in the literature generally provided only short representative lists of species as examples from these

habitats, or small groups of species capable of expressing certain types of adaptations. In this report, we present comprehensive lists of species associated with these habitats as a result of the compilation of species reported in the literature combined with extensive field records from many unique western habitats. It is our intent that these expanded lists will assist the new regional Arid West wetland supplement and the new Arid West regional wetland plant list panel in acknowledging and appreciating the ecological amplitude of these desert specialists.

# 2 Study Area

The ecosystem boundaries of this region follows the outline of the Arid West regional wetland supplement (U.S. Army Corps of Engineers 2006) and is overlain with the plant list regional boundaries currently used by the Fish and Wildlife Service (Fig. 1) (Reed 1988). This region contains mainly the lower elevation basins and does not include some of the higher elevation mountainous areas contained within the region; those are included in the Western Mountains, Valleys and Coast supplement (U.S. Army Corps of Engineers, in prep.). The region includes three main ecological habitats: the warm and cold deserts and the parts of California influenced by a Mediterranean climate.

# 3 Methods

An initial literature review was performed to identify species with physiological or morphological adaptations for life in specialized habitats. Unfortunately, the literature did not provide extensive lists of species for these habitats; therefore, personal data from the senior author's collection within this region during watershed-scale wetland delineations and other ecological studies completed over close to two decades were used to supplement the literature lists. The species lists compiled from the field records came from actual species observations recorded on data sheets. Species data were stored digitally, and records were supported by soils data and other site descriptions including geographic coordinates. The field data were sorted by habitat types and grouped into specialty categories. Data were then merged with the lists compiled from the literature to obtain the final version of species lists in each specialty habitat type.

Identification of species was done using many regional and local floras covering several floristic regions, including the Sonoran, Colorado Plateau, Great Basin, Chihuahuan, Apachian, Peninsular, Columbia Plateau, South Rocky Mountains Mogollon, and the Mojave areas (McLaughlin 1989). The groups of specialty habitats were developed from the literature and field visits to various locations. After species lists for each specialty group were compiled, wetland indicator statuses from the five FWS regions contained in the Arid West Region (Regions 6, 7, 8, 9, and 0) were derived from the 1988 Plant List (Reed 1988). Because of variations of synonyms in various floras across the region, depending on the date of publication, the synonyms were standardized using the List 88 names (Reed 1988) and their wetland plant indicator statuses. Current synonyms for many species are also provided based on the USDA PLANTS database (2007).

# 4 Results

## Group Descriptions

The following discussion describes the specialty habitats and the adaptive physiological and morphological features of the species that inhabit them. We report a total of 421 species, with 93 of those species shared in more than one habitat type. There were 48 playa species, 346 dry wash species, 62 dry wash phreatophytes, 32 hygro-halophytes, 47 xero-halophytes, and 17 phreatophytes with salt tolerance.

### Playa Edges

Playas can be defined as the flat, lower portions of an arid basin with internal drainage that pond water periodically and accumulate sediment (Stone 1956). Because of harsh physical conditions within a playa, such as compacted soil, high salinity, and unpredictable cycles of inundated/dry conditions, much of the vegetation is restricted to the edge of the playa (Lichvar et al. 2006). Two types of playas exist: hard and soft playas (Stone 1956). Hard playas lack groundwater within 5 m from the surface, while soft playas typically have groundwater within 5 m of the surface (Motts 1970, Neal 1975). These two conditions influence the type of plant species and communities present along the playa edge. Hard playa vegetation varies from xerophytic species (found in saline dry habitats) that closely resembles upland conspecific species, to halophytic species (found in saline wet habitats) of the "alkaline sink scrub" vegetation type (Barbour et al. 1987). Soft playa vegetation consists of succulent chenopods of the "alkaline sink scrub" (Lichvar et al. 2006).

Thorne (1976) classified vegetation found along playa edges as "alkaline scrub," which generally consists of scattered scrub of halophytic plants mostly in the Chenopodiaceae, Asteraceae, Brassicaceae, Fabaceae, and Poaceae families (Barbour and Billings 1988). Barbour and Billings (1988) also stated that 20% of this vegetation type consists of monocultures of single-perennial-species dominance. Vegetation found along the playa edges is often found on phreatophytic mounds (raised accumulations of soil and vegetation) that are 1–5 m high and have a circumference of 2–10 m (Lichvar et al. 2006, Lichvar and Sprecher 1996). The mounds form when wind-blown sand and silt accumulate around a phreatophyte

(species that have their roots in perennial groundwater or in the capillary fringe above the water table) (Hunt 1966) growing at the level of the playa surface and build successively upward (Lichvar et al. 2006). As you move away from the playa edge, salinity decreases; as a result the vegetation shifts from halophytic to xerophytic salt bush species, with a transition zone between the two stands. The xerophytic zone is then replaced by the Creosotebush community (Lichvar and Pringle 1992). Between the sandy edge of the playa and the foot of the mountains are highly permeable gravel fans where the water table is deep and xerophytes are able to thrive (Hunt 1966). Lower in elevation, some boundaries are seen where these gravel fans grade into sand at the edge of the playa; this boundary also correlates with the availability of groundwater. Adaptations expressed by the plants around the playa edge can include both salt- and drought-tolerance, depending on the species site requirements. Field experience has shown that the reliability of the status ratings of wetland plant species as indicators along playa edges is compromised by halophytes and phreatophytes responding to saline soils and groundwater at depths greater than the surface or near-surface hydrology required to meet wetland criteria (Lichvar et al. 2006). A list of 48 playa edge species is presented in Table 2.

Table 2. Species found along playa edges.

| 1988 synonymy | Current name | Playa type* | Region 6 | Region 7 | Region 8 | Region 9 | Region 0 |
|---|---|---|---|---|---|---|---|
| *Acamptopappus sphaerocephalus* (Harvey & Gray ex Gray) Gray 1,2 | | H | UPL | UPL | UPL | UPL | UPL |
| *Allenrolfea occidentalis* (S. Wats.) Kuntze | | SH | FACW | FACW | FACW | FACW+ | FACW+ |
| *Artemisia spinescens* D.C. Eat 7 | *Picrothamnus desertorum* Nutt. | H | UPL | UPL | UPL | UPL | UPL |
| *Atriplex canescens* (Pursh) Nutt. 2, 4,6,7 | | H | UPL | UPL | UPL | UPL | FACU |
| *Atriplex confertifolia* (Torr. & Frém.) S. Wats. 2,7,8 | | H | UPL | UPL | UPL | UPL | UPL |
| *Atriplex lentiformis* (Torr.) S. Wats. 2,6,7 | | SH | NO | FACW | FAC+ | NO | FAC |
| *Atriplex phyllostegia* (Torr. Ex.S. Wats.) S. Wats. 6 | | H | NO | NO | FACW | NI | FACW |
| *Atriplex polycarpa* (Torr.) S. Wats. 2 | | H | NO | FACU- | FACU | NO | FACU |
| *Atriplex spinifera* J.F. Macbr. | | H | NO | NO | NO | NO | FAC |
| *Atriplex torreyi* (S. Wats.) S. Wats 8 | | H | NO | NO | FAC- | NO | FAC |

Table 2 (cont.). Species found along playa edges.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Chrysothamnus nauseosus* (Pallas ex Pursh) Britt ssp. *mohavensis* (Greene) Hall & Clements 6 | *Ericameria nauseosa* (Pallas ex Pursh) Nesom & Baird ssp. *consimilis* (Greene) Nesom & Baird var. *mohavensis* (Greene) Nesom & Baird | H | UPL | UPL | UPL | UPL | UPL |
| *Delphinium recurvatum* Greene 7 | | H | UPL | UPL | UPL | UPL | UPL |
| *Distichlis spicata* (L.) Greene 5,6 | | SH | FACW+ | FACW | FAC+* | FACW | FACW |
| *Erigeron bellidiastrum* Nutt. 12 | | H | UPL | UPL | UPL | UPL | UPL |
| *Forestiera neomexicana* Gray | *Forestiera pubescens* Nutt | | FAC- | FACU | FAC+ | NO | FAC |
| *Frankenia grandifolia* Cham. & Schlecht. 7 | *Frankenia salina* (Molina) I.M. Johnston | S | NO | NO | NO | NO | FACW+ |
| *Geraea canescens* Torr. & Gray | | H | UPL | UPL | UPL | UPL | UPL |
| *Grayia spinosa* (Hook.) Moq. 7 | | SH | UPL | UPL | UPL | UPL | UPL |
| *Isocoma acradenia* (Greene) Greene | | H | NO | NI | NI | NO | NI |
| *Helianthus ciliaris* D.C.12 | | H | FAC | FAC | NI | NI | NI* |
| *Heliotropium curassavicum* I.7 | | SH | FACW | FACW* | OBL | OBL | OBL |
| *Hoffmannseggia glauca* (Ortega) Eifert 12 | | H | FAC | FACU | FACU- | NO | FACU |
| *Hymenoclea salsola* Torr. & Gray ex Gray 2 | | H | UPL | UPL | UPL | UPL | UPL |
| *Hymenoxys odorata* D.C. 12 | | H | UPL | UPL | UPL | UPL | UPL |
| *Juncus bufonius* L. | | SH | OBL | OBL | OBL | FACW+ | FACW+ |
| *Kochia californica* S. Wats.2,7,8 | *Bassia californica* (S. Wats.) A.J. Scott | SH | NO | NO | FACW | NO | FACW |
| *Lepidium dictyotum* Gray 7, | | H | NO | NO | FACW+ | FACW | OBL |
| *Monolepis nuttalliana* (J.A. Schultes) Greene | | SH | FACU* | FAC | FACW | FAC- | FACW |
| *Nama demissum* Gray | | H | UPL | UPL | UPL | UPL | UPL |
| *Nitrophila occidentalis* (Moq.) S. Wats 2,7, 6 | | SH | NO | NO | FAC+ | FACW | FACW |
| *Oligomeris linifolia* (Vahl) J.F. Macbr. | | H | UPL | UPL | UPL | UPL | UPL |
| *Panicum obtusum* Kunth 12 | | H | FAC+ | FAC | FACU | NO | NO |
| *Phacelia distans* Benth.2 | | H | UPL | UPL | UPL | UPL | UPL |
| *Pluchea sericea* (Nutt.) Coville 2,7 | | S | NO | NI | FACW- | FACW | NO |

Table 2 (cont.). Species found along playa edges.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Polypogon monspeliensis* (L.) Desf. | | SH | FACW+ | FACW+ | FACW+ | FACW+ | FACW+ |
| *Psathyrotes ramosissima* (Torr.) Gray | | H | UPL | UPL | UPL | UPL | UPL |
| *Salicornia subterminalis* Parish 2,7 | *Arthrocnemum subterminale* (Parish) Standl. | S | NO | NO | NO | NO | OBL |
| *Schismus barbatus* (Loefl. ex L.) Thellung | | H | UPL | UPL | UPL | UPL | UPL |
| *Scirpus acutus* Muhl. ex Bigelow 2 | *Schoenoplectus acutus* (Muhl. ex Bigelow) A.& D. Löve | S | OBL | OBL | OBL | OBL | OBL |
| *Sesuvium verrucosum* Raf. 7 | | SH | FACW- | FACW | FACW+ | NI | FACW |
| *Sida leprosa* (Ortega) K. Schum 7,12 | *Malvella leprosa* (Ortega) Krapov. | SH | FAC | FACW | FAC | FACU | FAC* |
| *Sphaerophysa salsula* (Pallas) DC. 12 | | H | NI | NI | FAC | UPL | NI |
| *Sporobolus airoides* (Torr.) Torr. 2,7 | | S | FAC | FAC | FAC | FAC- | FAC+ |
| *Sisymbrium orientale* L. | | H | UPL | UPL | UPL | UPL | UPL |
| *Suaeda suffrutescens* S. Wats. 4 | | SH | UPL | UPL | UPL | UPL | UPL |
| *Suaeda torreyana* S. Wats. 2,6,7,7,8 | *Suaeda moquinii* (Torr.) Greene | SH | FACW- | FAC | FAC+ | FAC | FAC+ |
| *Tamarix aphylla* (L.) Karst. 4 | | S | FACW | FAC | FACW | NO | FACW- |
| *Wislizenia refracta* Engelm. 7 | | SH | FACW | FACU- | FACU- | NO | NI |

*S = soft playa; H = hard playa; SH = soft and hard playa

1 Barbour and Billings (1988)
2 Barbour and Major (1977)
3 Hunt (1966)
4 Hunt (1975)
5 Scott et al. (2000)
6 Stone (1956)
7 Thorne (1976)
8 Vasek (1983)
9 Wallace et al. (1980)
10 Went and Westergaard (1949)
11 West (1983)
12 Wondzell et al. (1990)

### Dry Wash Species

Desert dry wash species occur in dry channel beds of intermittent and ephemeral streams that are dominated by woody phreatophytes, large shrubs, and trees, as well as scattered evergreen and drought-deciduous shrubs. Intermittent stream channels often have a groundwater table close to the surface that allows for a greater diversity of vegetation, while ephemeral streams do not have a water table as close to the surface,

therefore limiting the abundance of vegetation (Katz 2004). Many of the species found along dry washes occur in both the dry wash and adjacent upland habitats (Nilsen et al. 1984). As a response to channel disturbance it is common to find upland species that have been washed down into the stream channel during storm events; occasionally upland species invade the stream channel. Dry washes are often dominated by phreatophyte species, which have roots anchored deep below the surface in or near the water table (Rundel and Gibson 1996). However, not all dry wash species are phreatophytes; many other species, such as grasses and shallower-rooted shrubs, rely on groundwater discharge or precipitation (Scott et al. 2000). When there is a slight increase in soil moisture, there is also an increase in vegetation biomass, height, and stem density that is not found in the uplands areas (Lichvar and Wakeley 2004). Otherwise, dry washes tend to have lower species cover values because of frequent disturbances in the wash as a response to storm discharge events, lack of developed soils, and well-drained coarse soil textures that lack soil moisture. These disturbances and stresses affect germination rates and vegetative responses. Larger washes tend to have more scattered trees and shrubs, such as willows (*Salix* spp.), cottonwoods (*Populus* spp.), and mesquites (*Prosopis* spp.), that are able to survive because their root systems have the ability to make contact with deeper groundwater that is lacking immediately outside the slopes of the wash. Researchers in the Southwest have noted that some plant species seem to be restricted as obligate dry wash species, while others take advantage of the water reserves in the channel but are not restricted to it; these are also referred to as facultative dry wash species (Lichvar and Wakeley 2004). Because of these types of observations, Dick-Peddie and Hubbard (1977) noted that obligate riparian species of the Southwest may be facultative in more mesic regions. Table 3 lists 346 dry wash species.

Table 3. Dry wash species.

| 1988 synonymy | Current name | Region 6 | Region 7 | Region 8 | Region 9 | Region 0 |
|---|---|---|---|---|---|---|
| *Abronia villosa* S. Wats. 7 | | UPL | UPL | UPL | UPL | UPL |
| *Adenostoma fasciculatum* Hook. & Arn. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Adenostoma sparsifolium* Torr. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Agave americana* L. var. *expansa* (Jacobi) Gentry 7 | | UPL | UPL | UPL | UPL | UPL |
| *Agropyron intermedium* (Host) Beauv. var. *trichophorum* (Link) Halac. | *Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey | UPL | UPL | UPL | UPL | UPL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Agropyron trachycaulum* (Link) Malte 2 | *Elymus trachycaulus* (Link) Gould ex Shinners | FAC- | FAC | FACU | FAC | NI* |
| *Agrostis exarata* Trin. 2 | | FACW | FACW | FACW | FACW | FACW |
| *Alisma triviale* Pursh | | UPL | UPL | UPL | UPL | UPL |
| *Allenrolfea occidentalis* (S. Wats.) Kuntze 1,2,10 | | FACW | FACW | FACW | FACW+ | FACW+ |
| *Alnus rhombifolia* Nutt. | | NO | NO | NI | FACW | FACW |
| *Alyssum alyssoides* (L.) L. | | UPL | UPL | UPL | UPL | UPL |
| *Amaranthus blitoides* S. Wats. | | FAC | FACU | FACU | FACW | FACW |
| *Amaranthus palmeri* S. Wats. | | FACU- | FACU | FACU | NO | FACU |
| *Ambrosia acanthicarpa* Hook. | | UPL | UPL | UPL | UPL | UPL |
| *Ambrosia confertiflora* DC. | | UPL | UPL | UPL | UPL | UPL |
| *Ambrosia dumosa* (Gray) Payne 1,2,7,9 | | UPL | UPL | UPL | UPL | UPL |
| *Ambrosia psilostachya* DC. 2 | | FAC- | FAC | FACU* | FACU+ | FAC |
| *Amorpha fruticosa* L. | | FACW | FACW+ | FACW | NO | FAC* |
| *Amsinckia menziesii* (Lehm.) A. Nels. & J.F. Macbr. 2 | | UPL | UPL | UPL | UPL | UPL |
| *Amsinckia tessellata* Gray | | UPL | UPL | UPL | UPL | UPL |
| *Anagallis arvensis* L. | | FACW- | FAC | FAC+ | FAC | FAC |
| *Anemopsis californica* (Nutt.) Hook. & Arn. 7 | | FACW+ | OBL | OBL | NI | OBL |
| *Apiastrum angustifolium* Nutt. | | UPL | UPL | UPL | UPL | UPL |
| *Apium graveolens* L. | | NI | NI | NI | NI | FACW* |
| *Arctostaphylos glauca* Lindl. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia californica* Less. 2 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia douglasiana* Bess. ex Hook. | | NO | NO | FAC | FACW | FACW |
| *Artemisia dracunculus* L. 2 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia filifolia* Torr. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia ludoviciana* Nutt. 2 | | UPL | UPL | FACU | UPL | FACU- |
| *Artemisia palmeri* Gray | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia tridentata* Nutt. 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia tridentata* Nutt. ssp. *parishii* (Gray) Hall & Clements 2 | | UPL | UPL | UPL | UPL | UPL |
| *Arundo donax* L. 2,7 | | FAC+ | FACW | FACW | NO | FACW |
| *Aster subspicatus* Nees | *Symphyotrichum subspicatum* (Nees) Nesom | NO | NI | FAC | FACW | FAC |
| *Astragalus lentiginosus* Dougl. ex Hook. | | NO | NI | NI | NI | NI |
| *Atriplex californica* Moq. | | NO | NO | NO | NO | FAC |
| *Atriplex canescens* (Pursh) Nutt. 1,2,7 | | UPL | UPL | UPL | UPL | FACU |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Atriplex confertifolia* (Torr. & Frém.) S. Wats. 1,2,7,10 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex hymenelytra* (Torr.) S. Wats. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia ludoviciana* Nutt. 2 | | UPL | UPL | FACU | FACU-* | FACU- |
| *Atriplex parryi* S. Wats. 1 | | NO | NO | FACW | NO | FACW |
| *Atriplex polycarpa* (Torr.) S. Wats. 1,2 | | NO | FACU- | FACU | NO | FACU |
| *Atriplex spinifera* J.F. Macbr.1 | | NO | NO | NO | NO | FAC |
| *Avena barbata* Pott ex Link | | UPL | UPL | UPL | UPL | UPL |
| *Avena fatua* L. | | UPL | UPL | UPL | UPL | UPL |
| *Azolla filiculoides* Lam. | | NO | OBL | NI | OBL | OBL |
| *Baccharis pilularis* DC. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Baccharis sarothroides* Gray 1,7 | | NO | FAC- | NI | NO | FAC |
| *Baccharis viminea* DC. | *Baccharis salicifolia* (Ruiz & Pavón) Pers | NI | FACW | FACW | NO | FACW |
| *Barbarea verna* (P. Mill.) Aschers. | | UPL | UPL | UPL | UPL | UPL |
| *Bassia hyssopifolia* (Pallas) Kuntz | | FACW- | FACW- | FACW | FACW | FAC |
| *Beckmannia syzigachne* (Steud.) Fern. | | NO | OBL | OBL | OBL | OBL |
| *Berula erecta* (Huds.) Coville | | OBL | OBL | OBL | OBL | OBL |
| *Bothriochloa barbinodis* (Lag.) Herter | | UPL | UPL | UPL | UPL | UPL |
| *Brassica nigra* (L.) W.D.J. Koch | | UPL | UPL | UPL | UPL | UPL |
| *Brickellia californica* (Torr. & Gray) Gray 2 | | FAC | FACU+ | UPL | FACU- | FACU |
| *Briza minor* L. | | FAC+ | NO | NO | FAC | FACW |
| *Bromus carinatus* Hook. & Arn. | | UPL | UPL | UPL | UPL | UPL |
| *Bromus diandrus* Roth 2 | | UPL | UPL | UPL | UPL | UPL |
| *Bromus mollis* L. | *Bromus hordeaceus* L. | UPL | UPL | UPL | UPL | FACU |
| *Bromus rubens* L. | *Bromus madritensis* L. ssp *rubens* (L.) Husnot | NI | NI | NI | NI | NI |
| *Bromus tectorum* L. 2 | | UPL | UPL | UPL | UPL | UPL |
| *Calystegia longipes* (S. Wats.) brummitt | | UPL | UPL | UPL | UPL | UPL |
| *Camissonia claviformis* (Torr. & Gr(Torr. & Frém.) Raven 2 | | UPL | UPL | UPL | UPL | UPL |
| *Cardamine californica* (Nutt.) Greene | | NO | NO | NO | NI | UPL* |
| *Cardaria pubescens* (C.A. Mey.) Jarmolenko | | UPL | UPL | UPL | UPL | UPL |
| *Carex barbarae* Dewey | | NO | NO | NO | FAC+ | FACW |
| *Carex praegracilis* W. Boott | | FACW | FACW+ | FACW | FACW | FACW- |
| *Carex spissa* Bailey | | NO | NI | NO | NO | FAC* |
| *Carex triquetra* Boott | | UPL | UPL | UPL | UPL | UPL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Caulanthus inflatus* S. Wats. | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus crassifolius* Torr. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus cuneatus* (Hook.) Nutt. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus greggii* Gray 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus tomentosus* Parry 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus verrucosus* Nutt.1 | | UPL | UPL | UPL | UPL | UPL |
| *Centaurea calcitrapa* L. | | UPL | UPL | UPL | UPL | UPL |
| *Centaurea maculosa* auct. non Lam. | *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek | UPL | UPL | UPL | UPL | UPL |
| *Centaurea melitensis* L. | | UPL | UPL | UPL | UPL | UPL |
| *Centaurium venustum* (Gray) B.L. Robins. | | UPL | UPL | UPL | UPL | UPL |
| *Cercocarpus minutiflorus* Abrams | *Cercocarpus montanus* Raf. var. *minutiflorus* (Abrams) F.L. Martin | UPL | UPL | UPL | UPL | UPL |
| *Chenopodium leptophyllum* (Moq.) Nutt. ex. S. Wats. 2 | | FACU | FACU | FACU | FACU | UPL |
| *Chorizanthe watsonii* Torr. & Gray | | UPL | UPL | UPL | UPL | UPL |
| *Chrysothamnus nauseosus* (Pallas ex Pursh) Britt ssp. *albicaulis* (Nutt.) Hall & Clements 2,7 | *Ericameria nauseosa* (Pallas ex Pursh) Nesom & Baird ssp. *nauseosa* var. *speciosa* (Nutt.) Nesom & Baird | UPL | UPL | UPL | UPL | UPL |
| *Chrysothamnus teretifolius* (Dur. & Hilg.) Hall 2 | *Ericameria teretifolia* (Dur. & Hilg.) Jepson | UPL | UPL | UPL | UPL | UPL |
| *Cirsium occidentale* (Nutt.) Jepson | | UPL | UPL | UPL | UPL | UPL |
| *Cirsium vulgare* (Savi) Ten. | | FACU | FACU | FAC | FACU | FACU |
| *Claytonia parviflora* Dougl. ex Hook. | | UPL | UPL | UPL | UPL | UPL |
| *Conium maculatum* L. | | FACW | OBL | FACW | FACW- | FACW |
| *Conyza canadensis* (L.) Cronq. 1 | | UPL | FACU | UPL | FACU | FAC |
| *Cortaderia jubata* (Lem.) Stapf | | UPL | UPL | UPL | UPL | UPL |
| *Cotula coronopifolia* L. | | NO | OBL | NI | FACW+ | FACW+ |
| *Crassula aquatica* (L.) Schoenl. 2 | | OBL | OBL | NI | OBL | OBL |
| *Cressa truxillensis* Kunth 7 | | FACW- | FACW- | FACW | FACW | FACW |
| *Croton californicus* Muell.-Arg. 2 | | UPL | UPL | UPL | UPL | UPL |
| *Croton pottsii* (Klotzsch) Muell.-Arg. | | UPL | UPL | UPL | UPL | UPL |
| *Cryptantha circumscissa* (Hook. & Arn.) I.M. Johnston | | UPL | UPL | UPL | UPL | UPL |
| *Cryptantha clevelandii* Greene | | UPL | UPL | UPL | UPL | UPL |
| *Cryptantha intermedia* (Gray) Greene | | UPL | UPL | UPL | UPL | UPL |
| *Cryptantha nevadensis* A. Nels. & Kennedy | | UPL | UPL | UPL | UPL | UPL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Cucurbita foetidissima* Kunth | | UPL | UPL | UPL | UPL | UPL |
| *Cuscuta californica* Hook. & Arn. | | UPL | UPL | UPL | UPL | UPL |
| *Cynara cardunculus* L. | | UPL | UPL | UPL | UPL | UPL |
| *Cynodon dactylon* (L.) Pers. | | FACU+ | FACU | FAC | FACU | FAC |
| *Cyperus eragrostis* Lam. | | NO | NO | NO | NI | FACW |
| *Cyperus alternifolius* L. | *Cyperus involucratus* Rottb. | FACW+ | NO | NO | NO | OBL |
| *Cyperus odoratus* L. | | FACW | FACW+ | NO | NO | FACW |
| *Cytisus multiflorus* (L'Hér.) Sweet | | UPL | UPL | UPL | UPL | UPL |
| *Deschampsia danthonioides* (Trin.) Munro | | NO | FACW- | FACW | FACW- | FACW |
| *Datura stramonium* L. | | UPL | UPL | UPL | UPL | UPL |
| *Descurainia pinnata* (Walt.) Britt. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Distichlis spicata* (L.) Greene 1,2,7 | | FACW+ | FACW | FAC+* | FACW | FACW |
| *Dudleya cymosa* (Lem.) Britt. & Rose | | UPL | UPL | UPL | UPL | UPL |
| *Echinochloa crus-galli* (L.) Beauv. | | FACW- | FACW- | FACW | FACW | FACW |
| *Echinochloa crus-pavonis* (Kunth) J.A. Schultes var. *macera* (Wieg.) Gould | | OBL | OBL | FACW | FACW | OBL |
| *Echinochloa muricata* (Beauv.) Fern. | | FACW | FACW | FACW | FACW | FACW |
| *Eleocharis macrostachya* Britt. | | OBL | OBL | OBL | OBL | OBL |
| *Eleocharis montevidensis* Kunth | | FACW+ | FACW | NO | NO | FACW |
| *Eleocharis obtusa* (Willd.) J.A. Schultes | | OBL | OBL | OBL | OBL | OBL |
| *Elymus cinereus* Scribn. & Merr. 1,2 | *Leymus cinereus* (Scribn. & Merr.) A. Löve | NO | NI | NI | NI | NI |
| *Elymus glaucus* Buckl. | | NO | FACU | FACU | FACU | FACU |
| *Elymus multisetus* M.E. Jones | | UPL | UPL | UPL | UPL | UPL |
| *Encelia farinosa* Gray ex Torr. 1,2, 7 | | UPL | UPL | UPL | UPL | UPL |
| *Ephedra nevadensis* S. Wats.2,7, 9 | | UPL | UPL | UPL | UPL | UPL |
| *Epilobium canum* (Greene) Raven | | UPL | UPL | UPL | UPL | UPL |
| *Epilobium ciliatum* Raf. | | FACU | FACW | FAC | FACW- | FACW |
| *Erigeron foliosus* Nutt. | | UPL | UPL | UPL | UPL | UPL |
| *Eriodictyon crassifolium* Benth. | | UPL | UPL | UPL | UPL | UPL |
| *Eriogonum deflexum* Torr. | | UPL | UPL | UPL | UPL | UPL |
| *Eriogonum fasciculatum* Benth. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Eriogonum inflatum* Torr. & Frém. | | UPL | UPL | UPL | UPL | UPL |
| *Eriophyllum confertiflorum* (DC.) Gray 1, 2 | | UPL | UPL | UPL | UPL | UPL |
| *Erodium botrys* (Cav.) Bertol. | | UPL | UPL | UPL | UPL | UPL |
| *Erodium cicutarium* (L.) L'Hér. ex Ait. | | UPL | UPL | UPL | UPL | UPL |
| *Eucalyptus globus* Labill. | | UPL | UPL | UPL | UPL | UPL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Eurotia lanata* (Pursh) Moq. | *Krascheninnikovia lanata* (Pursh) A.D.J. Meeuse & Smit | UPL | UPL | UPL | UPL | UPL |
| *Eustoma exaltatum* (L.) Salisb. ex G. Don | | FACW | OBL* | NO | NO | OBL* |
| *Festuca arundinacea* Schreb. | *Schedonorus phoenix* (Scop.) Holub | FAC- | NA* | FACW- | FACU- | FAC- |
| *Festuca octoflora* Walt. 1,2 | *Vulpia octoflora* (Walt.) Rydb. var. *octoflora* | NI | NI | UPL | UPL | UPL |
| *Festuca rubra* L. | | FAC* | FACW- | FAC | FAC | FAC |
| *Foeniculum vulgare* P. Mill. | | FAC | FACU | FACU | FACU | FACU |
| *Forestiera pubescens* Nutt. var. *neomexicana* (Gray) E. Murr. | *Forestiera neomexicana* Gray | FAC- | FACU | FAC+ | NO | FAC |
| *Frankenia jamesii* Torr. ex Gray | | UPL | UPL | UPL | UPL | UPL |
| *Fraxinus velutina* Torr. 2,7 | | FAC | FAC+ | FAC | NO | FACW |
| *Galium angustifolium* Nutt. ex Gray | | UPL | UPL | UPL | UPL | UPL |
| *Galium aparine* L. | | FAC- | FACU | FACU | FACU | FACU |
| *Galium triflorum* Michx. | | FACU | FACU+ | FACU | FACU | FACU |
| *Geranium carolinianum* L. | | UPL | UPL | UPL | UPL | UPL |
| *Geranium molle* L. | | UPL | UPL | UPL | UPL | UPL |
| *Gilia latiflora* (Gray) Gray | | UPL | UPL | UPL | UPL | UPL |
| *Gilia leptalea* (Gray) Greene | *Navarretia leptalea* (Gray) L.A. Johnson | UPL | UPL | UPL | UPL | UPL |
| *Gilia leptomeria* Gray | *Aliciella leptomeria* (Gray) J.M. Porter | UPL | UPL | UPL | UPL | UPL |
| *Gnaphalium beneolens* A. Davids | *Pseudognaphalium canescens* (DC.) W.A. Weber ssp. *beneolens* (A. Davids.) | UPL | UPL | UPL | UPL | UPL |
| *Gnaphalium californicum* DC. | *Pseudognaphalium californicum* (DC.) A. Anderb. | UPL | UPL | UPL | UPL | UPL |
| *Gnaphalium canescens* DC. | *Pseudognaphalium canescens* (DC.) W.A. Weber ssp. *canescens* | UPL | UPL | FACU | NO | FACU* |
| *Gutierrezia microcephala* (DC.) Gray | | UPL | UPL | UPL | UPL | UPL |
| *Gutierrezia sarothrae* (Pursh) Britt. & Rusby 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Haplopappus acradenia* (Gray) Blake 7 | *Isocoma acradenia* (Greene) Greene | NO | NI | NI | NO | NI |
| *Haplopappus cooperi* (Gray) Hall 2 | *Ericameria cooperi* (Gray) Hall | UPL | UPL | UPL | UPL | UPL |
| *Helianthus annuus* L. | | FAC | FAC- | FACU | FACU+ | FAC- |
| *Heliotropium curassavicum* L. | | FACW | FACW* | OBL | OBL | OBL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Heliotropium curassavicum* L. var. *oculatum* (Heller) I.M. Johnston 7 | | FACW | FACW* | OBL | OBL | OBL |
| *Heteromeles arbutifolia* (Lindl.) M. Roemer 1 | | UPL | UPL | UPL | UPL | UPL |
| *Heterotheca grandiflora* Nutt. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Hilaria mutica* (Buckl.) Benth. 1 | *Pleuraphis mutica* Buckl. | UPL | UPL | UPL | UPL | UPL |
| *Hordeum leporinum* L. ssp. *leporinum* (Link) Arcang. | | NI | NI | NI | NI | NI |
| *Hordeum murinum* L. | | NI | NI | NI | NI | NI |
| *Hymenoclea monogyra* Torr. & Gray ex Gray 1,7 | | UPL | UPL | UPL | UPL | UPL |
| *Hymenoclea salsola* Torr. & Gray ex Gray 1,2,7,9 | | UPL | UPL | UPL | UPL | UPL |
| *Iris missouriensis* Nutt. | | NO | FACW- | OBL* | FACW+ | OBL |
| *Isocoma menziesii* (Hook. & Arn.) Nesom | | NO | NO | NO | NO | FACW* |
| *Iva hayesiana* Gray | | NO | NO | NO | NO | FACW |
| *Juncus actus* L. 2 | | NO | FACW | FACW+ | NO | FACW |
| *Juncus balticus* Willd. | *Juncus arcticus* Willd. ssp. *littoralis* (Engelm.) Hultén | NO | NO | FACW | NO | NO |
| *Juncus dubius* Engelm. | | NO | NO | NI | NI | FACW* |
| *Juncus mexicanus* Willd. ex J.A. & J.H. Schultes | | FACW | FACW | FACW | NO | FACW |
| *Lactuca serriola* L. 1 | | FAC | FAC | FACU | FAC- | FAC |
| *Larrea divaricata* auct. non Cav. 1,7 | *Larrea tridentata* (Sessé & Moc. ex DC.) Coville var. *tridentata* | UPL | UPL | UPL | UPL | UPL |
| *Lasthenia californica* D.C. ex Lindl. | | NO | UPL | NO | UPL | FACU* |
| *Leman minor* L. | | OBL | OBL | OBL | OBL | OBL |
| *Lepidium densiflorum* Schrad. | | FAC | FAC | FACU | FAC- | FAC |
| *Lepidium fremontii* S. Wats. 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Lepidium latifolium* L. | | NO | NI | FAC | FAC | FACW |
| *Lepidium virginicum* L. | | FAC- | UPL* | FACU | FACU | FACU |
| *Lepidospartum squamatum* (Forssk.) Aschers. | | UPL | UPL | UPL | UPL | UPL |
| *Lessingia lemmonii* Gray | | UPL | UPL | UPL | UPL | UPL |
| *Limonium californicum* (Boiss.) Heller | | NO | NO | NO | NO | OBL |
| *Limonium limbatum* Small | | FACW+ | FACW | NO | NO | NO |
| *Lolium multiflorum* Lam. | *Lolium perenne* L. ssp. *multiflorum* (Lam.) Husnot | FACU | FACU | FACU | FACU | FAC* |
| *Lolium perenne* L. | | FACU | FACU | FACU | FACU | FAC* |
| *Lonicera subspicata* Hook. & Arn | | UPL | UPL | UPL | UPL | UPL |
| *Lonicera japonica* Thunb. | | FAC | FACU* | FAC+ | NO | NI |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Lotus corniculatus* L. | | FAC | FACU+ | NO | FAC | FAC |
| *Lotus scoparius* (Nutt.) Ottley 2 | | UPL | UPL | UPL | UPL | UPL |
| *Lupinus bicolor* Lindl. | | UPL | UPL | UPL | UPL | UPL |
| *Lycium cooperi* Gray 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Lygodesmia exigua* (Gray) Rydb. 2 | | UPL | UPL | UPL | UPL | UPL |
| *Lythrum hyssopifolia* L. | | NO | NO | NO | OBL | FACW |
| *Machaeranthera pinnatifida* (Hook.) Shinners | | UPL | UPL | UPL | UPL | UPL |
| *Macheranthera tortifolia* (Torr. & Gray) Cronq. & Keck 2,9 | *Xylorhiza tortifolia* (Torr. & Gray) Greene var. *tortifolia* | UPL | UPL | UPL | UPL | UPL |
| *Marah macrocarpus* (Greene) Greene 2 | | UPL | UPL | UPL | UPL | UPL |
| *Marrubium vulgare* L. | | FACW- | FAC+ | FACU | FACU+ | FAC |
| *Matricaria matricarioides* (Less.) T. Porter | *Matricaria discoidea* DC. | UPL* | FACU | FACU | FACU | FACU |
| *Medicago polymorpha* L. | | UPL | UPL | UPL | UPL | UPL |
| *Medicago sativa* L. | | UPL | UPL | UPL | UPL | UPL |
| *Melilotus alba* Medik. | *Melilotus officinalis* (L.) Lam. | FACU | FACU+ | FACU | FACU | FACU+ |
| *Melilotus indica* (L.) All. | | FACU | FACU+ | FACU | FACU | FAC |
| *Melilotus officinalis* (L.) Lam. | | FACU | FACU+ | FACU | FACU | FACU |
| *Mentha arvensis* L. | | FACW | FACW | FACW | FAC | FACW |
| *Mentha spicata* L. | | FACW | FACW* | FACW | OBL | OBL |
| *Mentzelia albicaulis* (Dougl. ex Hook.) Dougl. ex Torr. & Gray | | UPL | UPL | UPL | UPL | UPL |
| *Mimulus aurantiacus* W. Curtis 2 | *Diplacus aurantiacus* (W. Curtis) Jepson ssp. *aurantiacus* | UPL | UPL | UPL | UPL | UPL |
| *Mimulus guttatus* DC. | | NO | OBL | OBL | OBL | OBL |
| *Muhlenbergia porteri* Scribn. ex Beal 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Muhlenbergia rigens* (Benth.) A.S. Hitchc. | | FACU* | FACU* | UPL | NO | FACW |
| *Najas guadalupensis* (Spreng.) Magnus | | OBL | OBL | OBL | OBL | OBL |
| *Nassella lepida* (A.S. Hitchc.) Barkworth | | UPL | UPL | UPL | UPL | UPL |
| *Nasturtium officinale* Ait. F. | | OBL | OBL | OBL | OBL | OBL |
| *Nicotiana glauca* (S. Wats.) S. Wats. | | FAC | FAC | NI | NO | FAC |
| *Oenothera californica* (S. Wats.) S. Wats. | | UPL | UPL | UPL | UPL | UPL |
| *Opuntia bigelovii* Engelm. 2 | *Cylindropuntia bigelovii* (Engelm.) F.M. Knuth | UPL | UPL | UPL | UPL | UPL |
| *Opuntia littoralis* (Engelm.) Cockerell | | UPL | UPL | UPL | UPL | UPL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Opuntia phaeacantha* Engelm. var. *discata* (Griffiths) L. Benson & Walkington 1 | *Opuntia engelmannii* Salm-Dyck ex Engelm. | UPL | UPL | UPL | UPL | UPL |
| *Opuntia ramosissima* Engelm 1,2 | *Cylindropuntia ramosissima* (Engelm.) F.M. Knuth | UPL | UPL | UPL | UPL | UPL |
| *Orthocarpus luteus* Nutt. | | NO | FACU- | FACU | FACU- | FACU |
| *Oryzopsis hymenoides* (Roemer & J.A. Schultes) Ricker ex Piper 1,2, 9 | *Achnatherum hymenoides* (Roemer & J.A. Schultes) Barkworth | FACU+ | FACU- | UPL | UPL | UPL |
| *Oxalis albicans* Kunth | | UPL | UPL | UPL | UPL | UPL |
| *Dichanthelium acuminatum* (SW.) Gould & C.A. Clark | | FAC | FAC | FACW | FAC | FACW |
| *Panicum capillare* L. | | FAC | FAC | FACU | FAC | FAC |
| *Panicum dichotomiflorum* Michx. | | FACW | FAC | FACW | FACW | FACW |
| *Panicum hallii* Vassey | | FACU | FACU | UPL | NO | NO |
| *Paspalum dilatatum* Poir. | | FAC | FAC | NO | NI | FAC |
| *Pennisetum setaceum* (Forssk.) Chiov. | | UPL | UPL | UPL | UPL | UPL |
| *Petalonyx thurberi* Gray 1,7 | | UPL | UPL | UPL | UPL | UPL |
| *Petroselinum crispum* (P. Mill.) Nyman ex A.W. Hill | | UPL | UPL | UPL | UPL | UPL |
| *Phacelia tanacetifolia* Benth. | | UPL | UPL | UPL | UPL | UPL |
| *Phalaris arundinacea* L. | | FACW+ | OBL | OBL | FACW | OBL |
| *Phleum pratense* L. | | FACU | FACU | FACU | FACU | FACU |
| *Phytolacca americana* L. | | FAC- | NI | NO | NI | NI |
| *Picris echioides* L. | | NO | NO | NO | NO | FAC* |
| *Pinus coulteri* D. Don 1 | | UPL | UPL | UPL | UPL | UPL |
| *Plagiobothrys bracteatus* (T.J. Howell) I.M. Johnston | | NO | NO | NO | FACW+ | OBL |
| *Plantago elongata* Pursch | | FACW- | NO | FACW | FACW | FACW* |
| *Plantago erecta* Morris | | UPL | UPL | UPL | UPL | UPL |
| *Plantago lanceolata* L. | | FAC | FAC | FACU | FACU+ | FAC- |
| *Plantago major* L. | | FAC+ | FACW | FAC | FAC+ | FACW- |
| *Plantanus racemosa* Nutt. 7 | | NO | NO | NO | NO | FACW |
| *Pluchea odorata* (L.) Cass. | | NO | NO | NO | NO | NO |
| *Pluchea purpurascens* (Sw.) DC. | *Pluchea odorata* (L.) Cass. | NO | NO | NO | NO | NO |
| *Pluchea sericea* (Nutt.) Coville 1,2,7, 10 | | NO | NI | FACW- | FACW | NO |
| *Poa annua* L. | | FAC | FAC- | FAC | FAC- | FACW- |
| *Poa glauca* Vahl var. *rupicola* (Nash ex Rydb.) Boivin | *Poa glauca* Vahl ssp. *rupicola* (Nash ex Rydb.) W.A. Weber | UPL | UPL | UPL | UPL | UPL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Poa pratensis* L. | | FACU+ | FACU | FACU | FACU+ | FACU |
| *Poa secunda* J. Presl 2 | | UPL | UPL | UPL | UPL | UPL |
| *Polygonum lapathifolium* L. | | FACW- | OBL | OBL | FACW+ | OBL |
| *Polygonum punctatum* Ell. | | FACW | OBL | OBL | OBL | OBL |
| *Polypogon monpeliensis* (L.) Desf. | | FACW+ | FACW+ | FACW+ | FACW+ | FACW+ |
| *Polystichum imbricans* (D.C. Eat.) D.H. Wagner | | UPL | UPL | UPL | UPL | UPL |
| *Populus fremontii* S. Wats. 1,2,5,7 | | FACW- | FACW | FACW* | NO | FACW |
| *Populus tremula* L. 7 | | FAC- | FACU | FAC | FAC+ | FAC+ |
| *Portulaca oleracea* L. | | FAC | FAC | FAC | FAC | FAC |
| *Prosopis glandulosa* Torr.1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Pseudoclappia arenaria* Rydb. | | UPL | UPL | UPL | UPL | UPL |
| *Pteridium aquilinum* (L.) Kuhn | | FAC- | FACU | FACU | FACU | FACU |
| *Quercus agrifolia* Née 1 | | UPL | UPL | UPL | UPL | UPL |
| *Quercus chrysolepis* Liebm. 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Quercus dumosa* Nutt. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Rhus integrifolia* (Nutt.) Benth. & Hook. f. ex Brewer & S. Wats. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Rhus ovata* S. Wats. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Ribes speciosum* Pursh | | UPL | UPL | UPL | UPL | UPL |
| *Ricinus communis* L. | | FACU | FAC- | NI | NO | FACU |
| *Rorippa nasturium-aquaticum* (L.) Hayek 2 | *Nasturtium officinale* Ait. f. | OBL | OBL | OBL | OBL | OBL |
| *Rosa californica* Cham. & Schlecht. | | NO | NO | NO | NI | FAC+ |
| *Rudbeckia californica* Gray | | NO | NO | NO | FACU+ | FACW |
| *Rumex crispus* L. | | FACW | FACW | FACW | FACW | FACW- |
| *Rumex hymenosepalus* Torr. | | UPL | UPL | UPL | UPL | UPL |
| *Salicornia utahensis* Tidestrom 1 | *Sarcocornia utahensis* (Tidestrom) A.J. Scott | FACW* | FACW | OBL | NO | OBL |
| *Salicornia virginica* L. | *Salicornia depressa* Standl. | OBL* | OBL | NO | OBL | OBL |
| *Salix exigua* Nutt. 7 | | FACW+ | OBL | OBL | OBL | OBL |
| *Salix gooddingii* Ball 1,2,5,7 | | FACW+ | OBL | FACW | NO | OBL |
| *Salix laevigata* Bebb 7 | | UPL | UPL | UPL | UPL | UPL |
| *Salix lasiolepis* Benth. 7 | | FACW | FACW | FACW | FACW | FACW |
| *Salsola tragus* L. | | FACU | FACU | FACU | FACU | FACU |
| *Salsola kali* L. 1 | | FACU | FACU | FACU | UPL | FACU+ |
| *Salvia apiana* Jepson | | UPL | UPL | UPL | UPL | UPL |
| *Salvia carduacea* Benth. | | UPL | UPL | UPL | UPL | UPL |
| *Salvia columbariae* Benth. 2 | | UPL | UPL | UPL | UPL | UPL |
| *Salvia mellifera* Greene 2 | | UPL | UPL | UPL | UPL | UPL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Sambucus mexicanus* K. Presl ex DC. ssp. *cerulea* (Raf.) E. Murr. | *Sambucus nigra* L. ssp. *canadensis* (L.) R. Bolli | FAC | FAC | FACU | NO | FAC |
| *Samolus ebracteatus* Kunth | | FACW* | OBL | NI | NO | NO |
| *Sanicula crassicaulis* Poepp. ex DC. | | UPL | UPL | UPL | UPL | UPL |
| *Sarcobatus vermiculatus* (Hook.) Torr. 1,2 | | FACU+ | FACU+ | FACU* | FACU+ | FACU |
| *Schismus barbatus* (Loefl. ex L.) Thellung 2 | | UPL | UPL | UPL | UPL | UPL |
| *Scirpus acutus* Muhl. Ex Bigelow | *Schoenoplectus acutus* var. *acutus* (Muhl. ex Bigelow) A.& D. Löve | OBL | OBL | OBL | OBL | OBL |
| *Scirpus americanus* (Pers.) Volk. ex Schinz & R. Keller | | OBL | OBL | OBL | OBL | OBL |
| *Scirpus californicus* (C.A. Mey.) Palla | | OBL | OBL | NO | NO | OBL |
| *Scirpus cernuus* (Vahl) Roemer & J.A. Schultes | | NO | NO | NO | OBL | OBL |
| *Scirpus microcarpus* J. & K. Presl | | NO | OBL | OBL | OBL | OBL |
| *Scirpus robustus* Pursh | *Schoenoplectus robustus* (Pursh) M.T. Strong | OBL | NO | NO | NO | OBL |
| *Scrophularia californica* Cham. & Schlecht. | | NO | FACW- | NO | FACW- | FAC |
| *Senecio vulgaris* L. | | NI | NI | UPL | FACU | NI* |
| *Sesuvium verrucosum* Raf. 1,7 | | FACW- | FACW | FACW+ | NI | FACW |
| *Setaria glauca* (L.) Beauv. | *Setaria pumila* (Poir.) Roemer & J.A. Schultes ssp. pumila | FAC | FAC | FACU | FAC | FAC |
| *Setaria viridis* (L.) Beauv. | | UPL | UPL | UPL | UPL | UPL |
| *Sisymbrium altissimum* L. 2 | | FACU+ | FAC | FACU- | FACU- | FACU |
| *Sisyrinchium bellum* S. Wats. | | NO | NO | NO | FACW- | FAC |
| *Sitanion hystrix* (Nutt.) J.G.Smith 1,2 | *Elymus elymoides* (Raf.) Swezey | FACU- | UPL | UPL | FACU- | FACU |
| *Solanum elaeagnifolium* Cav. | | UPL | UPL | UPL | UPL | UPL |
| *Solanum parishii* Heller | | UPL | UPL | UPL | UPL | UPL |
| *Solidago californica* Nutt. | | UPL | UPL | UPL | UPL | UPL |
| *Solidago spectabilis* (D.C. Eat.) Gray var. *confinis* (Gray) Cronq. | | NO | NO | NI | NO | FAC |
| *Sonchus arvensis* L. | | NI | NI | FACU | FACU+ | FACU |
| *Sonchus apser* (L.) Hill | | FAC- | FACW | FACU | FAC- | FAC |
| *Sonchus oleraceus* L. | | UPL* | UPL* | UPL | UPL | NI* |
| *Sporobolus airoides* (Torr.) Torr. 1,2 | | FAC | FAC | FAC | FAC- | FAC+ |
| *Sporobolus contractus* A.S. Hitchc. | | UPL | UPL | UPL | UPL | UPL |
| *Sporobolus wrightii* Munro ex Scribn. | | UPL | UPL | UPL | UPL | UPL |
| *Stachys ajugoides* Benth. | | NO | NO | NO | NO | OBL |

Table 3 (cont.). Dry wash species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Stephanomeria exigua* Nutt. | | UPL | UPL | UPL | UPL | UPL |
| *Stipa speciosa* Swallen 2 | *Achnatherum diegoense* (Swallen) Barkworth | NO | NO | NO | NO | FACW* |
| *Achnatherum speciosum* (Trin. & Rupr.) Barkworth | | UPL | UPL | UPL | UPL | UPL |
| *Streptanthella longirostris* (S. Wats.) Rydb. | | UPL | UPL | UPL | UPL | UPL |
| *Suaeda moquinii* (Torr.) Greene | | NO | FACW | FACW | FACW | NO |
| *Suaeda suffrutescens* S. Wats. | | OBL | OBL | NO | NO | NO |
| *Tamarix parviflora* DC. 7 | | FACW | NI | FACW | NI | FAC |
| *Tamarix ramosissima* Ledeb. 7 | | FACW | NI | FACW | FACW | FAC |
| *Taraxacum officinale* G.H. Weber ex Wiggers | | FACU+ | FACU | FACU+ | FACU | FACU |
| *Toxicodendron diversilobum* (Torr. & Gray) Greene | | UPL | UPL | UPL | UPL | UPL |
| *Trifolium repens* L. | | FACU+ | NI | FACU | FACU+ | FACU+ |
| *Typha angustifolia* L. 7 | | OBL | NI | OBL | OBL | OBL |
| *Typha latifolia* L. 7 | | OBL | OBL | OBL | OBL | OBL |
| *Urtica dioica* L. | | FAC | NI | FAC | FAC+ | FACW |
| *Verbesina encelioides* (Cav.) Benth. & Hook. f. ex Gray | | FAC | FAC | FACU | NO | FAC |
| *Veronica americana* Schwein. ex Benth. | | NI | OBL | OBL | OBL | OBL |
| *Veronica anagallis-aquatica* L. | | OBL | OBL | OBL | OBL | OBL |
| *Veronica peregrina* L. | | OBL | OBL | FACW+ | OBL | OBL |
| *Vicia americana* Muhl. ex Willd. | | NI | NI | NI | NI | NI |
| *Vicia cracca* L. | | UPL | UPL | UPL | UPL | UPL |
| *Vitis californica* Benth. | | NO | NI | NO | FACU | FACW |
| *Vitis girdiana* Munson | | UPL | UPL | UPL | UPL | UPL |
| *Vulpia myuros* (L.) K.C. Gmel. | | FAC | FACW | FACW- | FAC | FACU* |
| *Washingtonia filifera* (L. Linden) H. Wendl. 2,7 | | NO | FACW | NO | NO | FACW |
| *Xanthium strumarium* L. | | FAC- | NI | FAC | FAC | FAC+ |
| *Yucca brevifolia* Engelm. | | UPL | UPL | UPL | UPL | UPL |

1 Barbour and Billings (1988)
2 Barbour and Major (1977)
3 Hunt (1966)
4 Hunt (1975)
5 Scott et al. (2000)
6 Stone (1956)
7 Thorne (1976)
8 Vasek (1983)
9 Wallace et al. (1980)
10 Went and Westergaard (1949)
11 West (1983)
12 Wondzell et al. (1990)

### Dry Wash Phreatophytes

Dry wash phreatophytes (Table 3) can be found along intermittent and ephemeral watercourses and in depressions where the stored water or water table is near the surface in arid riparian habitats. They are generally limited to areas where there is a permanent undergroundwater supply. This adaptation enables them to avoid the rigors of the arid environment by having roots in constant contact with the fringe of capillary water above a water table (Hunt 1966). Because of their deep rooting system, desert phreatophytes have low water stress tolerance and high water stress avoidance (Nilsen et al. 1984). These species, known as obligate phreatophytes, are usually limited to the narrow, gallery forest directly adjacent to the channel that is dominated by cottonwood (*Populus* spp.) willows *(Salix* spp.), and mesquite (*Prosopis* spp.) species (Scott et al. 2000, Lichvar and Sprecher 1996). Other species are able to take advantage of groundwater when present but can also tolerate periods of low water availability. These facultative phreatophytes occur where water and salts accumulate (Barbour et al. 1987). Dry wash phreatophytes have several mechanisms to avoid drought, especially in the summer when it is the hottest and driest; these include deciduousness and a very low stomatal conductance (Nilsen et al. 1984). Table 4 lists 62 dry wash phreatophytes.

Table 4. Dry wash phreatophytes.

| 1988 synonymy | Current name | Region 6 | Region 7 | Region 8 | Region 9 | Region 0 |
|---|---|---|---|---|---|---|
| *Adenostoma fasciculatum* Hook. & Arn. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Adenostoma sparsifolium* Torr. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Allenrolfea occidentalis* (S. Wats.) Kuntze 2,3 | | FACW | FACW | FACW | FACW+ | FACW+ |
| *Ambrosia dumosa* (Gray) Payne 2 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex canescens* (Pursh) Nutt. 2, 3 | | UPL | UPL | UPL | UPL | FACU |
| *Atriplex confertifolia* (Torr. & Frém.) S. Wats. 1,2,7,10 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex hymenelytra* (Torr.) S. Wats. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex parryi* S. Wats. 1 | | NO | NO | FACW | NO | FACW |
| *Atriplex polycarpa* (Torr.) S. Wats. 1,2 | | NO | FACU- | FACU | NO | FACU |
| *Atriplex spinifera* J.F. Macbr. 1 | | NO | NO | NO | NO | FAC |
| *Baccharis pilularis* DC. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Baccharis salicifolia* (Ruiz & Pavón) Pers. | | NI | FACW | FACW | NO | FACW |

Table 4 (cont.). Dry wash phreatophytes.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Baccharis sarothroides* Gray 2,7 | | NO | FAC- | NI | NO | FAC |
| *Baccharis viminea* DC. 1 | *Baccharis salicifolia* (Ruiz & Pavón) Pers. | NI | FACW | FACW | NO | FACW |
| *Ceanothus crassifolius* Torr. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus cuneatus* (Hook.) Nutt. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus greggii* Gray 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus tomentosus* Parry 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Ceanothus verrucosus* Nutt. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Chrysothamnus nauseosus* (Pallas ex Pursh) Britt ssp. *albicaulis* (Nutt.) Hall & Clements 2,7 | *Ericameria nauseosa* (Pallas ex Pursh) Nesom & Baird ssp. *nauseosa* var. *speciosa* (Nutt.) Nesom & Baird | UPL | UPL | UPL | UPL | UPL |
| *Encelia farinosa* Gray ex Torr. 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Eriogonum fasciculatum* Benth 1 | | UPL | UPL | UPL | UPL | UPL |
| *Eriogonum inflatum* Torr. & Frém. 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Eucalyptus globulus* Labill. | | UPL | UPL | UPL | UPL | UPL |
| *Frankenia jamesii* Torr. ex Gray | | UPL | UPL | UPL | UPL | UPL |
| *Fraxinus velutina* Torr. | | FAC | FAC+ | FAC | NO | FACW |
| *Gutierrezia microcephala* (DC.) Gray | | UPL | UPL | UPL | UPL | UPL |
| *Gutierrezia sarothrae* (Pursh) Britt. & Rusby 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Haplopappus acradenius* (Greene) Blake 7 | *Isocoma acradenia* (Greene) Greene | NO | NI | NI | NO | NI |
| *Haplopappus cooperi* (Gray) Hall 2 | *Ericameria cooperi* (Gray) Hall | UPL | UPL | UPL | UPL | UPL |
| *Heterotheca grandiflora* Nutt. 1 | | UPL | UPL | UPL | UPL | UPL |
| *Hymenoclea monogyra* Torr. & Gray ex Gray 1,7 | | UPL | UPL | UPL | UPL | UPL |
| *Hymenoclea salsola* Torr. & Gray ex Gray 1,2,7,9 | | UPL | UPL | UPL | UPL | UPL |
| *Isocoma menziesii* (Hook. & Arn.) Nesom | | NO | NO | NO | NO | FACW* |
| *Lepidium latifolium* L. | | NO | NI | FAC | FAC | FACW |
| *Lepidospartum squamatum* (Forssk.) Aschers. | | UPL | UPL | UPL | UPL | UPL |
| *Lotus scoparius* (Nutt.) Ottley 2 | | UPL | UPL | UPL | UPL | UPL |
| *Petalonyx thurberi* Gray 1,7 | | UPL | UPL | UPL | UPL | UPL |
| *Plantanus racemosa* Nutt. 7 | | NO | NO | NO | NO | FACW |
| *Pluchea odorata* (L.) Cass. | | NO | NO | NO | NO | NO |
| *Pluchea purpurascens* (Sw.) DC. | *Pluchea odorata* (L.) Cass. | NO | NO | NO | NO | NO |
| *Pluchea sericea* (Nutt.) Coville 3 | | NO | NI | FACW- | FACW | NO |

Table 4 (cont.). Dry wash phreatophytes.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Populus fremontii* S. Wats. 1,2,5,7 | | FACW- | FACW | FACW* | NO | FACW |
| *Prosopis glandulosa* Torr. 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Quercus agrifolia* Née 1 | | UPL | UPL | UPL | UPL | UPL |
| *Quercus chrysolepis* Liebm. 1,2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Quercus dumosa* Nutt. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Rhus integrifolia* (Nutt.) Benth. & Hook. f. ex Brewer & S. Wats. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Rhus ovata* S. Wats. 1,2 | | UPL | UPL | UPL | UPL | UPL |
| *Ribes speciosum* Pursh | | UPL | UPL | UPL | UPL | UPL |
| *Salix exigua* Nutt. 7 | | FACW+ | OBL | OBL | OBL | OBL |
| *Salix gooddingii* Ball 1,2,5,7 | | FACW+ | OBL | FACW | NO | OBL |
| *Salix laevigata* Bebb 7 | | UPL | UPL | UPL | UPL | UPL |
| *Salix lasiolepis* Benth. 7 | | FACW | FACW | FACW | FACW | FACW |
| *Salsola kali* L. 1 | | FACU | FACU | FACU | FACU | FACU+ |
| *Suaeda moquinii* (Torr.) Greene | | NO | FACW | FACW | FACW | NO |
| *Suaeda suffrutescens* S. Wats. 3 | | OBL | NO | NO | NO | |
| *Tamarix parviflora* DC. 2 | | FACW | NI | FACW | NI | FAC |
| *Tamarix ramosissima* Ledeb 2. | | FACW | NI | FACW | FACW | FAC |
| *Washingtonia filifera* (L. Linden) H. Wendl. 2,7 | | NO | FACW | NO | NO | FACW |
| *Xanthium strumarium* L. | | FAC- | NI | FAC | FAC | FAC+ |
| *Yucca brevifolia* Engelm. 1,2,7 | | UPL | UPL | UPL | UPL | UPL |

1 Barbour and Billings (1988)
2 Barbour and Major (1977)
3 Hunt (1966)
4 Hunt (1975)
5 Scott et al. (2000)
6 Stone (1956)
7 Thorne (1976)
8 Vasek (1983)
9 Wallace et al. (1980)
10 Went and Westergaard (1949)
11 West (1983)
12 Wondzell et al. (1990)

### Hygro-halophytes

Hygro-halophytes are plant species found growing in desert lowlands under naturally saline conditions where water occurs within 1 m of the surface and is occasionally found at the surface (West 1983). In many locations, water occurs within 1 m of the surface as a result of mountain precipitation that has infiltrated into the headwaters of the aquifer where it enters the regional groundwater aquifer and flows down to the center of the basin or wash (West 1983). Here the groundwater table can intersect the ground surface and provide base flow to streams and water for vegetation (Scott et al. 2000). Hygro-halophytes can be found in dry washes where the groundwater table is near the surface and along the

playa edges. The roots of these species do not usually reach down to a permanent groundwater source; therefore, most species have adapted more of a fibrous-like root system, allowing them to obtain water at or near the surface. An example of a hygro-halophtye is iodinebush (*Allenrolfea occidentalis*), one of the most salt-tolerant plants in the desert, located in dry washes and around playa edges. *A. occidentalis* is found on salt-crusted silty faces of carbonate soils. This species also occurs on saline flats where the ground is covered by a coating of salt in blister-like augmentation that is 2.54–5.08 cm (1–2 in.) high and 15.24–30.48 cm (6–12 in.) wide. This crust can contain up to 20% water-soluble salts and has the ability to retain moisture for long periods of time following a rain event (Hunt 1966). Adaptations of hygro-halophytes include postponing their major development until the warmest part of the year, when they are "sub-irrigated" by the snowmelt from the mountains and the runoff into the basins, resulting in delayed leaf growth that causes species to take on a greenish cast until summer (West 1983). In addition to delayed leaf growth, hygro-halophytes have developed mechanisms for salt tolerance and avoidance. The list of 32 of hygro-halophytic species is provided in Table 5.

Table 5. Hygro-halophytic species.

| 1988 synonymy | Current name | Region 6 | Region 7 | Region 8 | Region 9 | Region 0 |
|---|---|---|---|---|---|---|
| *Allenrolfea occidentalis* (S. Wats.) Kuntze 1,2,7, 10,11 | | FACW | FACW | FACW | FACW+ | FACW+ |
| *Aster frondosus* (Nutt.) Torr.& Gray 7 | *Symphyotrichum frondosum* | NO | NI | OBL | FACW+ | OBL |
| *Baccharis sergiloides* Gray 7 | | NO | FAC- | FACU | NO | FAC |
| *Baccharis salicifolia* (Ruiz & Pavón) Pers. 3,7 | | FACW | FACW | FACW | NO | FACW- |
| *Chrysothamnus paniculatus* (Gray) Hall 7 | *Ericameria paniculata* (Gray) Rydb. | UPL | UPL | UPL | UPL | UPL |
| *Cordylanthus canescens* Gray 7 | *Cordylanthus maritimus* Nutt. ex Benth. ssp. *canescens* (Gray) Chuang & Heckard | NO | NO | OBL | OBL | OBL |
| *Cressa truxillensis* Kunth 7 | | FACW- | FACW- | FACW | FACW | FACW |
| *Distichlis spicata* (L.) Greene 7 | | FACW+ | FACW | FAC+* | FACW | FACW |
| *Hemizonia pungens* (Hook. & Arn.) Torr. & Gray 7 | *Centromadia pungens* (Hook. & Arn.) Greene ssp. *pungens* | NO | FACW+ | FAC | UPL | FAC |
| *Juncus cooperi* Engelm. 7, 10 | | NO | FACW | FACW+ | NO | FACW |
| *Juncus mexicanus* Willd. ex J.A. & J.H. Schultes 7 | | FACW | FACW | FACW | NO | FACW |

Table 5 (cont.). Hygro-halophytic species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Limonium limbatum* Smal | | FACW+ | FACW | NO | NO | NO |
| *Muhlenbergia asperifolia* (Nees & Meyen ex Trin.) Parodi 7 | | FACW | FACW | FACW+ | FACW | FACW |
| *Nitrophila occidentalis* (Moq.) S. Wats 2 | | NO | FAC+ | FACW | FACW | FACW |
| *Salicornia utahensis* Tidestrom 2 | *Sarcocornia utahensis* (Tidestrom) A.J. Scott | FACW* | FACW | OBL | NO | OBL |
| *Salicornia subterminalis* Parish 1, 11 | *Arthrocnemum subterminale* (Parish) Standl. | NO | NO | NO | NO | OBL |
| *Sesuvium verrucosum* Raf. 7 | | FACW- | FACW | FACW+ | NI | FACW |
| *Sporobolus airoides* (Torr.) Torr 1, 7 | | FAC | FAC | FAC | FAC- | FAC+ |
| *Sarcobatus vermiculatus* (Hook.) Torr. 2 | | FACU+ | FACU+ | FACU* | FACU+ | FACU |
| *Scirpus americanus* (Pers.) Volk. ex Schinz & R. Keller | | OBL | OBL | OBL | OBL | OBL |
| *Scirpus californicus* (C.A. Mey.) Palla | | OBL | OBL | NO | NO | OBL |
| *Scripus olneyi* Gray 2, 7 | *Schoenoplectus americanus* (Pers.) Volk. ex Schinz & R. Keller | OBL | OBL | OBL | OBL | OBL |
| *Scripus paludosus* L. 7 | *Schoenoplectus maritimus* (L.) Lye | NI | NI | NI | OBL | OBL |
| *Scirpus nevadensis* S. Wats. 7 | | NO | NO | OBL | OBL | OBL |
| *Suaeda depressa* (Pursh)S. Wats. 1,2 | *Suaeda calceoliformis* (Hook.) Moq. | FACW- | FACW | FACW | FACW- | FACW+ |
| *Suaeda moquinii* (Torr.) Greene | | NO | FACW | FACW | FACW | NO |
| *Suaeda nigra* J.F. Macbr. 2 | *Suaeda moquinni* (Torr.) Greene | NO | FACW | FACW | FACW | NO |
| *Suaeda suffrutescens* S. Wats. 3 | | OBL | OBL | NO | NO | NO |
| *Suaeda torreyana* S. Wats. 1,2,7 | *Suaeda moquinni* (Torr.) Greene | FACW- | FAC | FAC+ | FAC | FAC+ |
| *Triglochin maritima* L. 2 | | NO | OBL | OBL | OBL | OBL |
| *Typha latifolia* L. 7 | | OBL | OBL | OBL | OBL | OBL |
| *Typha anugustifolia* L. 7 | | OBL | NI | OBL | OBL | OBL |

1 Barbour and Billings (1988)
2 Barbour and Major (1977)
3 Hunt (1966)
4 Hunt (1975)
5 Scott et al. (2000)
6 Stone (1956)
7 Thorne (1976)
8 Vasek (1983)
9 Wallace et al. (1980)
10 Went and Westergaard (1949)
11 West (1983)
12 Wondzell et al. (1990)

### Xero-halophytes

Xero-halophytes are located within dry saline habitats. These habitats are formed inside high-evaporation basins and lowlands of the desert topography. Within this area, xero-halophytes can be found growing in soils with salt concentrations up to 6% and a water table well below 1 m (Barbour and Billings 1988). Xero-halophytes do not have root systems like phreatophytes that can extend to the water table; they typically do not even extend to the top of the capillary fringe. Instead, they have a shallow root system that allows them to obtain water from rains, dews, and vadose water. Vadose water is the major source of water that is used to sustain xero-halophytes, and the availability has been correlated with many distribution patterns (Hunt 1966). Beyond the edge of a playa, xero-halophyte patches increase in size and density, but at the edge of the playa, intermittent patches are found on soil mounds (Barbour and Major 1977). These occurrences at the playa edge result from gravel fans extending from the mountains to the edge of the playa, providing an optimal habitat where the water table is deep and xero-halophytes are able to thrive in the dry environment (Hunt 1966).

To adapt to the dry conditions, many xero-halophytes have a set of larger leaves that are lost as soil conditions become severely dry; in addition, they develop a second set of smaller over-wintering leaves that photo-synthesize through the winter (West 1983). Other adaptations include vesiculated trichomes (bladder-like tips of leaf cells that recycle salt back to the environment) (Mozafar and Goodin 1970) to deal with high concentrations of salt and succulent leaves to allow for greater water storage (Gibson 1996). Glenn and Brown (1998) noted that the salts in the soil actually enhance the performance of seedlings in the dry and salty soil; this is contrary to the previous idea that these conditions were stress factors. Soil salts help xero-halophytes survive by lowering the leaf surface-to-area ratio and growth rate, decreasing the rate at which soil water is depleted and in return giving the species a longer life span (Glenn and Brown 1998). There are 47 species listed for xero-halophytes in Table 6.

Table 6. Xero-halophytic species.

| 1988 synonymy | Current name | Region 6 | Region 7 | Region 8 | Region 9 | Region 0 |
|---|---|---|---|---|---|---|
| *Ambrosia dumosa* (Gray) Payne 2, 9 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia arbuscula* Nutt. 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Artemisia spinescens* D.C. Eat. 1,2,7 | *Picrothamnus desertorum* Nutt. | UPL | UPL | UPL | UPL | UPL |

Table 6 (cont.). Xero-halophytic species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Artemisia tridentata* Nutt. 1, 7 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex canescens* (Pursh) Nutt. 1,2,7 | | UPL | UPL | UPL | UPL | FACU |
| *Atriplex confertifolia* (Torr. & Frém.) S. Wats. 1,2, 7, 10,11 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex corrugata* S. Wats. 1,7,11 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex cuneata* A. Nels. 1,7,11 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex falcata* (M.E. Jones) Standl. 1, 7, 11 | | NO | NO | FACW* | UPL | FAC* |
| *Atriplex hymenelytra* (Torr.) S. Wats. 2, 3,7, 10 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex polycarpa* (Torr.) S. Wats. 2,3,7 | | NO | FACU- | FACU | NO | FACU |
| *Atriplex gardneri* (Moq.) D. Dietr 1,7,11 | | UPL | UPL | UPL | UPL | UPL |
| *Atriplex parryi* S. Wats. 2,7 | | NO | NO | FACW | NO | FACW |
| *Atriplex polycarpa* (Torr.) S. Wats. 2,3,7 | | NO | FACU- | FACU | NO | FACU |
| *Atriplex spinosa* (Hook.) Collotzi 1,7,11 | *Grayia spinosa* (Hook.) Moq. | UPL | UPL | UPL | UPL | UPL |
| *Atriplex tridentata* Kuntze 1,7 | | NO | NO | FACW | NI | NO |
| *Baccharis viminea* DC. 1 | *Baccharis salicifolia* (Ruiz & Pavón) Pers | NO | NI | FACW | FACW | NO |
| Bromus tectorum L. 1,11 | | UPL | UPL | UPL | UPL | UPL |
| *Ceratoides lanata* (Pursh) J.T. Howell 1,7,9,10,11 | *Krascheninnikovia lanata* (Pursh) A.D.J. Meeuse & Smit | UPL | UPL | UPL | UPL | UPL |
| *Chrysothamnus nauseosus* (Pallas ex Pursh) Britt ssp. *arenarius* L.C. Anders. 2,7 | *Ericameria nauseosus* (Pallas ex Pursh) Nesom & Baird ssp. *consimilis* (Greene) Nesom & Baird var. *mohavensis* (Greene) Nesom & Baird | UPL | UPL | UPL | UPL | UPL |
| *Coleogyne ramosissima* Torr. 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Elymus cinereus* Scribn. & Merr. 1, 11 | *Leymus cinereus* (Scribn. & Merr.) A. Löve | NO | NI | NI | NI | NI |
| *Encelia farinosa* Gray ex Torr. 2,3,7 | | UPL | UPL | UPL | UPL | UPL |
| *Eriogonum inflatum* Torr. & Frém. 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Euphorbia prostrata* Ait. 3 | *Chamaesyce prostrata* (Ait.) Small | UPL | UPL | UPL | UPL | UPL |
| *Grayia spinosa* (Hook.) Moq. 2,7,9 | | UPL | UPL | UPL | UPL | UPL |
| *Halogeton glomeratus* (Bieb.) C.A. Mey.1, 11 | | UPL | UPL | UPL | UPL | UPL |
| *Hymenoclea salsola* Torr. & Gray ex Gray 3,7,9 | | UPL | UPL | UPL | UPL | UPL |

Table 6 (cont.). Xero-halophytic species.

| | | | | | | |
|---|---|---|---|---|---|---|
| *Kochia american* S. Wats. 1, 11 | *Bassia american* (S. Wats.) A.J. Scott | FAC- | FAC | FACU | FACU | FAC+ |
| *Larrea tridentata* (Sessé & Moc. ex DC.) Coville 2,3,7,9 | | UPL | UPL | UPL | UPL | UPL |
| *Lepidum perfoliatum* L. 1,11 | | FAC | UPL* | FACU- | FACU+ | FACU |
| *Lycium andersonii* Gray 2,7, 9 | | UPL | UPL | UPL | UPL | UPL |
| *Menodora spinescens* Gray 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Oryzopsis hymenoides* (Roemer & J.A. Schultes) Ricker ex Piper 2,11 | *Achnatherum hymenoides* (Roemer & J.A. Schultes) Barkworth | FACU+ | FACU- | UPL | UPL | UPL |
| *Purshia glandulosa* Curran 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Purshia tridentata* (Pursh) DC. 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Salsola kali* L.1, 11 | | FACU | FACU | FACU | UPL | FACU+ |
| *Sitanion hystrix* (Nutt.) J.G. Sm 1, 11 | *Elymus elymoides* (Raf.) Swezey | FACU- | UPL | UPL | FACU- | FACU |
| *Sphaeralcea ambigua* Gray 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Suaeda fruticosa* auct. non Forssk 1 | *Suaeda moquinii* (Torr.) Greene | FACW- | FAC | FAC+ | FAC | FAC+ |
| *Suaeda suffrutescens* S. Wats. 3 | | OBL | OBL | NO | NO | NO |
| *Tetradymia axillaris* A. Nels. 2,7 | | UPL | UPL | UPL | UPL | UPL |
| *Tidestromia oblongifolia* (S. Wats.) Standl 2,3 | | UPL | UPL | UPL | UPL | UPL |
| *Wyethia mollis* Gray 2, 7 | | UPL | UPL | UPL | UPL | UPL |

1 Barbour and Billings (1988)
2 Barbour and Major (1977)
3 Hunt (1966)
4 Hunt (1975)
5 Scott et al. (2000)
6 Stone (1956)
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### Phreatophytes with salt tolerance

Phreatophytes with salt tolerance are the dominant plants along playa margins and the extreme low slopes of alluvial fans. In these areas, the saturated zone, or the capillary fringe, is usually within 6 m of the land surface. It is here that the roots of the plant are anchored in order to access the water table (Lines 1979). Soils are sandy and silty and contain a high percentage of salts, which occur as hard layers on or just below the surface. Habitat conditions where these species grow allow them to have a dependable water supply, be independent of rains, and be able to respond to seasonal temperatures. The species reach their tolerance limit as the salinity of the groundwater increases farther into the playa, causing a precipitous decrease in numbers. The most abundant, salt-tolerant plants

found in this high tolerance zone are *Allenrolfea* and *Salicornia* (Hunt 1965). To flourish in these high salinities, species have to exclude the uptake of salts or have the ability to anatomically isolate and/or excrete them (West 1983). Table 7 lists 17 phreatophytes with salt tolerance.

Table 7. Phreatophytes with salt tolerance.

| 1988 synonymy | Current name | Region 6 | Region 7 | Region 8 | Region 9 | Region 0 |
|---|---|---|---|---|---|---|
| *Allenrolfea occidentalis* (S. Wats.) Kuntze 2,3 | | FACW | FACW | FACW | FACW+ | FACW+ |
| *Atriplex canescens* (Pursch) Nutt. 2,3 | | UPL | UPL | UPL | UPL | FACU |
| *Baccharis sergiloides* Gray 3 | | NO | FAC- | FACU | NO | FAC |
| *Distichlis spicata* (L.) Greene 2 | | FACW+ | FACW | FAC+* | FACW | FACW |
| *Juncus cooperi* Engelm. 2,3 | | NO | FACW | FACW+ | NO | FACW |
| *Phragmites communis* Trin. 3 | *Phragmites australis* (Cav.) Trin. ex Steud. | FACW | FACW+ | FACW+ | FACW+ | FACW |
| *Pluchea sericea* (Nutt.) Coville 2,3 | | NI | FACW- | FACW | NO | FACW |
| *Prosopis juliflora* (Sw.) DC. 2,3 | | FACU- | FACU | NI | NO | FACU |
| *Prosopis pubescens* Benth 3 | | FAC+ | FACW- | FAC | NO | FAC |
| *Sarcobatus vermiculatus* (Hook.) Torr. 2 | | FACU+ | FACU+ | FACU* | FACU+ | FACU |
| *Scirpus olneyi* Gray 3 | *Schoenoplectus americanus* (Pers.) Volk. ex Schinz & R. Keller | OBL | OBL | OBL | OBL | OBL |
| *Sporobolus airoides* (Torr.) Torr. 2,3 | | FAC | FAC | FAC | FAC- | FAC+ |
| *Suaeda fruticosa* auct. Non Forssk. 2 | *Suaeda moquinii* (Torr.) Greene | NO | FACW | FACW | FACW | NO |
| *Suaeda suffrutescens* S. Wats. 3 | | UPL | UPL | UPL | UPL | UPL |
| *Tamarix aphylla* (L.) Karst. 2,3 | | FACW | FAC | FACW | NO | FACW |
| *Tamarix gallica* L. 2,3 | | FACW- | NO | NO | NO | FACW |

1 Barbour and Billings (1988)
2 Barbour and Major (1977)
3 Hunt (1966)
4 Hunt (1975)
5 Scott et al. (2000)
6 Stone (1956)
7 Thorne (1976)
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## Application of the Lists

Compiling species lists from literature and field studies has traditionally been a mainstay of botanists for characterizing habitats. When knowledge of these specific adaptations and habitats are considered and organized into species lists, they can serve an important role in supporting the designation of wetland plant indicator statuses. In the past, wetland

indicator statuses have been assigned within regions based on presumed frequencies of occurrence in wetlands, but as discussed here in the context of habitat specific lists, they can also be used to evaluate and compare their occurrences in various wetland habitat types. Examples of the benefits of this approach can be seen in species that are found at the edges of playas. Of the two types of playas—hard and soft—25 of the 48 species reported from the playa edge list (Table 2) are generally associated with hard playas. Interestingly, the 25 species associated with hard playas had mostly UPL indicator status ratings, while those of soft playas had OBL and FACW ratings (Table 2). Soft playas typically have the three characteristics necessary to delineate a wetland: hydrophytic vegetation, hydric soils, and hydrologic indicators (Lichvar et al. 2006). In contrast, hard playas lack groundwater and vegetation and usually have only hydrologic indicators; therefore, they are considered WoUS and are delineated using Ordinary High Water Marks methods. This distinction between the different playa types helps put the differences in habitats in context and allows a refinement in the wetland plant indicator status by distinguishing wetlands from WoUS.

Besides these two types of playa species, there are opportunistic species that are occasionally found at the edge of playas that may also inhabit many other types of habitats. Many of these species in Table 2 have variable indicator statuses ratings that make them problematic for delineations. For example, *Monolepis nuttalliana* (J.A. Schultes) Greene is one of these opportunistic species that frequently occurs around playas and has a wetland plant indicator status ranging from FACW to FACU within the region. This species occurs around both soft and hard playas, and when occurring on a hard playa, its occurrence is more associated with salt content in the soil rather than soil moisture. Species with distribution patterns similar to this could be given different ratings for various playa types or assigned a rating that has a broader frequency of occurrence for wetlands. But without focusing on occurrence in different playa types, the reliability of the rating is lowered. By being able to put species in context with specific habitats, wetland plant indicator panels will be able to better judge the ratings they are assigning within the habitat context for species in these problematic groups.

Another supportive role of these specialized habitat lists is the ability to identify those species that occur in other habitats and assess their frequency based on their overall habitat preferences. For instance, *Suaeda moquinii* (Torr.) Greene, a halophytic species, occurred in each of the six

specialized groups. Since each of these habitats represents different hydrology and soil conditions, it is interesting to observe that this species has a FACW rating for its occurrences in a dry wash, where hydric soils almost never occur. The hydrology in dry washes is usually flashy; typically these habitats do not pond or stay saturated for more than 14 days and therefore lack the site conditions necessary to meet the hydrologic criteria of a wetland (Environmental Laboratory 1987). However, the site may be considered a WoUS based on other hydrology features used to delineate WoUS. In this ecological position, *S. moquinii* may be best considered a FAC or even a FACU species, depending on further observations and considerations. In contrast, this species is frequently encountered along the edges of soft playas where wetland features do occur and should be considered a FACW hydrophyte when placed in that context. With lists of species for specialized habitats ranging from playas to dry washes, indicator statuses can be compared across different habitats to ensure the usefulness and reliability of their ratings.

Riparian corridors, unlike some of the other specialized habitats, offer many inclusions of different types of habitats; therefore, it isn't surprising that the number of species in the dry wash is large (346) compared to the other specialized habitats. Some of the species in this list are associated with groundwater discharge and tend to have OBL or FACW ratings, while others include many of the phreatophytic shrubs that tap deeper groundwater resources. There are many upland species that get washed into channels during storm events and survive by responding to disturbances and conditions, such as soil texture, that mimic other habitat conditions where they typically reside and germinate. Thus, dry washes can provide a variety of micro-habitats all within one general habitat type.

The differences in geographic distribution patterns are more obvious when all these species from specialized habitats are compared by habitat occurrences across the Arid West region. Many species are reported from one or a few of the FWS regions, while others occur in all FWS regions. These variations in occurrences represent species distribution patterns associated with different floristic provinces. These differences point out that the flora of the Arid West region is not contiguous and identical across the entire region. The scale of the new ecoregion includes several floristic elements within the provinces. To assist with the floristic differences within the Arid West region, the new digital distribution maps complied by the Biota of North America Program (BONAP 2006) for the region can help clarify a species' geographic patterns.

# 5 Conclusions

Lists of species that occupy specialized habitats and are characterized by morphological and physiological adaptations can be used to better understand species ecology and occurrences across a region. This approach for considering all of a species' habitat preferences, range distributions, and special adaptations is valuable for assigning and increasing the reliability of wetland indicator statuses. Once wetland plant indicator statuses are assigned to a species, it is possible to double check the ratings by habitats to see if they fit the species occurrences across multiple habitats. It may not be possible to accomplish this for the entire wetland plant list for a region, but certain plant species and similarly acting species are recognized to have problematic wetland indicator statuses. For some of these species and groups, dividing species by habitats will allow for a better insight into wetland occurrence and will produce a more accurate hydrophytic vegetation determination.

Another method to develop more reliable wetland species lists is the use of subregions within a region. This has been done previously in the Northeast and Southeast regions, two former FWS regions, to accurately reflect the intraregional ecological variability of plant species (Reed 1997, Tiner 2006). The species occurrences shown in our tables imply that there are differences between different floristic provinces based on the presence or absence of species across the region. To adequately assign reliable indicator statuses to many species, it may be necessary, and helpful, for the Arid West region to be subdivided into smaller units, and then statuses can be assigned as needed on an individual basis by subregion.

The quality of the assigned wetland plant indicator statuses for any region relies on knowledge of a species' occurrence in wetlands, its occurrence in other types of habitats, and its biological responses to various habitat settings across its range. By having a more detailed perspective on a species' biological and distribution patterns, wetland plant ratings become more informative than just a frequency rating used in hydrophytic vegetation determinations. When evaluated within the context of how these ratings are used, the wetland plant list turns into a higher quality tool to be used by all wetland delineators and others who utilize the wetland plant list.

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Robert Lichvar and Lindsey Dixon

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U.S. Army Engineer Research and Development Center
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The U.S. Army Corps of Engineers is currently regionalizing and updating the national wetland delineation manual. This manual will use new ecosystem boundaries for the nation. A separate effort by the Corps will update the National Wetland Plant List within these same new ecosystem boundaries. The Arid West is an area of particular interest in the revision of the plant list because of the problematic indicator statuses for certain groups of plants. Many species in the Arid West have morphological and physiological adaptations that allow them to occur in specialized habitats, ranging from wetlands to uplands. In delineations, the indicator status of these species is not always accurate for the specific location. A combination of literature reviews and recorded species data from previous studies for six specialty habitats are presented and discussed; the species groups are playa edge species, dry wash species, dry wash phreatophytes, hygro-halophytes, xero-halophytes, and phreatophytes with salt tolerance. A total of 421 species, with 93 of those species shared in more than one habitat type, are reported, including 48 playa species, 346 dry wash species, 62 dry wash phreatophytes, 32 hygro-halophytes, 47 xero-halophytes, and 17 phreatophytes with salt tolerance. The list for each specialized habitat will be used to better understand species ecology and occurrences across the region and will ultimately help in assigning and increasing the reliability of wetland plant indicator statuses.

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